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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/593,036	09/15/2006	Kenji Suzuki	1592-0165PUS1	5742

2292 7590 10/02/2009
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EXAMINER	
SAYADIAN, HRAYR	

ART UNIT	PAPER NUMBER
2814	

NOTIFICATION DATE	DELIVERY MODE
10/02/2009	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mailroom@bskb.com

Office Action Summary	Application No.	Applicant(s)	
	10/593,036	SUZUKI ET AL.	
	Examiner	Art Unit	
	HRAYR A. SAYADIAN	2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _21 September 2009_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1 and 4-7_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1 and 4-7_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED OFFICE ACTION

35 U.S.C. § 103 Rejections of the Claims

1. The text of the appropriate paragraph of 35 U.S.C. § 103(a), providing the legal basis for the obviousness rejections in this Office Action, can be found in a previous Office Action.

2. Claims 1 and 4-7 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 5,434,100 to "Nakamura" in view of "Mirror Polishing of InP …, " by "Morisawa," Applied Surface Science, v. 92, (1996), pp. 147-150, and PGPUB US 2004/0214407 to "Westhoff." U.S. Pat. No. 4,987,094 to "Colas," U.S. Pat. No. 4,846,927 to "Takahashi," U.S. Pat. No. 7,304,310 to "Shortt," and Born and Wolf, "principles of Optics," pp 774-779, seventh edition (1999) are provided as evidence.

As to interpretation of scope of the claims: The claims are directed to manufacture, but still define it by how it reacts to characterizing incident radiation. For example, claims 1 and 7 are directed to a substrate that has a haze of not more than 1 ppm over an effectively used area. Claims 1, 6, and 7 specifically define haze as the ratio of intensity of scattered light to intensity of incident light. Using generic scattered intensity as part of the claims' definition results in the scope of "scattered" having has a scope reading on scattered intensity due to surface roughness, surface dislocations, or both.

The disclosure fails to define a measure or a metric for the "effective area." Such a recitation in the context of the disclosure of this application has a scope not excluding the effective area being of a size of individual electronic circuits, which at the time of the invention of this application is well known to be less than 0.5 microns in one dimension, and therefore having an area of less than 0.25 microns squared.

The Application explicitly discloses that the claimed substrate is made by "usual methods" of "mirror polishing." See, for example, paragraph [0036]. These usual substrate polishing methods, applied to LEC fabricated InP substrates then resulted in substrates having dislocation density of equal to or less than 1000 per cm-squared and

having haze of less than 1 ppm. The application then states that it is desired to have less than or equal to 500 dislocations per cm-squared.

The 9/21/2009 "Reply" now expressly recognizes (see page 6, the first sentence of the first full paragraph) that haze, as defined by the specification and the claims of this application, is due to two factors: (1) dislocations and (2) surface roughness. This express recognition now confirms Examiner's explanation provided in the 3/19/2009 Final Office Action in the third full paragraph of paragraph number 5 on page 5.

This confirms that haze is not a direct physical characteristic of a surface of a material. Rather, haze is a result of a combination of direct characteristics of the material surface. Examiner also notes that haze additionally depends on the extraneous characteristics of wavelength and angle of observation of the scattered reflection.

The specification describes the dislocations the substrate is to have as being less than 1000 per cm squared or preferably less than 500 per cm squared. And only claims 4 and 5 recite a scope of the claimed invention to be limited by the dislocation density being less than 1000 per cm squared and less than 500 per cm squared, respectively.

The specification however is silent on providing a quantitative measure of the surface roughness other than that the InP substrate surface was "mirror polish[ed] by a usual method." See, for example, paragraphs [0036], [0041], and [0048] of the PGPUB corresponding to this application.

As to the feature of "the InP substrate has a haze of 0.5 to 0.8 ppm," in new claim 6, Examiner notes that the original specification explained that an InP substrate with such a haze was one of not definite outcome of the practiced "usual method" of mirror polishing, but as being chosen from amongst the outcomes that included different hazes results. See, for example, paragraph [0037] of the PGPUB of this application stating "[t]he aforementioned substrates were measured in terms of haze in the surfaces ..., and ones with haze of 0.5 to 0.8 ppm in a measurable area (effectively used area) were selected."

The 9/21/2009 Reply sites several Japanese patent documents that are admitted to be directed to GaAs. The Reply however recognizes that these methods produce "'haze free' or haze levels of 0.1 ppm." The Reply however contends that performing mirror

finishing process on an InP wafer is much more difficult than doing so on GaAs wafer. See, for example, the first two sentences in the second full paragraph in page 6 of the Reply.

Again, Examiner notes that haze, as a measure of scattering from a surface, depends on the angle at which scattering is measured and on the wavelength of the light that is being scattered. See, for example, Born and Wolff, equations 88 and 91 on pages 778 and 779, respectively.

At best, however, the specification of this application describes measuring haze using 488 nm, but is silent on the angle of measurement. And only claims 1, 4, and 5 recite the haze of the InP substrate being measured at 488 nms.

<u>As to rejection over the prior art</u>: Examiner notes that obtaining an epitaxial InP substrate having a haze of not more than 1 ppm, as recited in claims 1 and 7 (or 0.5-0.8 ppm as recited in claim 6), along with the other recitations of the claims would have been obvious.

As to claims 1 and 7, Nakamura discloses an InP substrate and an InP epitaxial layer on the substrate. See, for example, the abstract. Wherein the substrate has an off-angle direction of 0.05-0.1 degrees from the <100> direction. Again, see, for example, the front-page figure and the abstract. The density of dislocations is less than 100 when the off-angles is 0.05-0.1 degrees. Again, see, for example, the front-page figure. And the substrate is mirror polished. See, for example, column 3, lines 12-16.

Assuming for the sake of argument only that substrate of Nakamura has 100 dislocations per cm squared, there would be a single dislocation in every million microns squared. The probability of a dislocation being present in a 15 x 15 microns squared (which is 225 microns squared in area, and is therefore about 1000 times the are of an individual semiconductor elemental device presently realizable in the semiconductor industry) is 225/1000,000, which is 1/4444. The Nakamura disclosed substrate therefore would be free of dislocation caused haze because its surface would have 4443 no dislocation 15x15 micron squared regions for every single 15x15 microns squared region

having a single dislocation. And at least over these 4443 no dislocations 15 x 15 micron regions, the haze due to dislocation would be zero.

There remains the issue of whether haze due to surface roughness would exist in the mirror finished surface of the InP substrate Nakamura discloses. Although Nakamura must at least be using "usual mirror" polishing/finishing, arguably Nakamura, as this application, fails to disclose a measure of the surface roughness of the implemented "usual method" of "mirror polishing."

The prior art at least as of 1996 however well knows how to mirror polish InP substrates so they are haze free due to surface roughness. See, for example, Morisawa.

Specifically, at least in the last sentence of the Introduction, and page 148, the last sentence in the right column of the paragraph running from the left column to the right column in page 148, and in the Conclusion on page 149, Morisawa explicitly discloses and motivates mirror polishing InP substrates and discloses how one would obtain "haze free" surfaces having surface roughness of about 0.3 nm (<u>which roughness size is the size of an atomic monolayer in InP</u>; see, for example, Colas, column 2, lines 33-36).

For an area of 15 x 15 microns squared, Morisawa discloses a measured maximum surface roughness (defined as "the maximum difference between the maximum and the minimum on a crossed curve;" see, for example, the last sentence on the left column in page 147, running into the right column on page 147) of 0.31 nm and a measured average surface roughness (defined as "the average value of the height from an average center line") of 0.04 nm. See, for example, the second from last sentence in section 3.2 on page 149.

To make scratch/damage free InP substrate surfaces, however, one of ordinary skill in the art at the time of the invention of this application however would have found it obvious to mirror polish the substrate disclosed by Nakamura as disclosed by Morisawa. This effect of mirror polishing by the method Morisawa discloses then would result in the Nakamura disclosed substrate having less than 100 dislocations per cm squared (<u>which is less than 1000 and 500 dislocations per cm squared as recited in claims 4 and 5</u>) and also being haze free as disclosed in Morisawa. And as the disclosure of this application admits (and the Reply confirms), see, for example, paragraphs [0018]-[0020]

of the PGPUB of this application, the InP epitaxial layer on such an InP substrate (Nakamura as modified by Morisawa) would have a haze less than 1 ppm.

Using model 6220 by KLA-Tencore (which produces the wavelength of 488 nms used by the inventors of this application to measure/determine the surface roughness of InP substrates that are the subject of this application) however is conventional and well known in the art. See, for example, Westhoff, paragraph [0072] describing using model 6220 to measure/determine haze in substrates having haze values less than 0.05 ppm (which is less than the claimed haze of 1 ppm).

It would therefore have been obvious for one of ordinary skill in the art to use model 6220 KLA-Tencore device (including its 488 nm wavelength light source) to confirm that InP epitaxial substrates have haze less than 1 ppm, at least for its art recognized suitability for intended purposes.

Indeed Shortt, assigned to KLA-Tencore, is evidence that the wavelength of 488 nms is used to determine haze. See, for example, column 7, lines 4-6. And Shortt discloses using the UV wavelength to determine has at less than 0.4 ppm, as small as 0.144 ppm. See, for example, Table 2 in column 21. The haze for the wavelength of 488 nms, which is longer than the ultra-violet wavelength used to measure the haze data in Table 2 would be less. See, Born and Wolff, the last paragraph on page 779, disclosing that scattering (haze) intensity is inversely proportional with the fourth power of the scattered wavelength.

It is noted however that a surface-reflection haze-free InP substrate would be haze-free at any observation wavelength and therefore the haze of a "haze free" InP measured at 488 micron wavelength would still be "haze free." The haze due to InP substrate resulting from the combined disclosures of Nakamura and Morisawa would still be not more than 1 ppm.

As to reciting the haze of the InP substrate being 0.5-0.8 ppm, as now recited in claim 6 (instead of not more than 1 ppm), Examiner notes that this application specifically admits that it is an outcome, amongst many different haze outcomes, of

choosing the dislocation density to be less than 1000 per cm squared (or at best less than 500 per cm squared; as disclosed by Nakamura) and a "usual method" for "mirror polishing." Absent a limitation in claim 6 of a specific angle and observation wavelength for the measured haze of 0.5-0.8, Examiner notes that such a haze value would be measured at some wavelength and at some angle of observation for the InP substrates obtained by the combined disclosures of Nakamura and Morisawa.

Additionally, Examiner notes that the art well recognizes (at least as evidenced by Westhoff and Morisawa) that Haze is an important indication of surface uniformity, which uniformity critically affects device semiconductor fabrication and performance. According to well-established patent precedents, therefore, it would have been obvious to optimize (for example by routine experimentation) the value of observed Haze to optimize device fabrication and performance by way of choosing the surface uniformity versus cost.

In the interest of compact prosecution, Examiner notes that the LEC (the method used to produce the InP of Example 2 of this application, but not claimed) is well-recognized high productivity method to produce substantially dislocation free InP. See, for example, Takahashi, the abstract; column 3, lines 47-60; and examples 1 and 2, described in columns 3 and 4.

<u>Response to Applicant's Argument(s)</u>

3. The arguments in the 9/21/2009 "Reply" to the 10/7/2008 non-final Office Action have been fully considered. These arguments however are not found persuasive.

Specifically admitting that the art well knows of mirror finishing that result in zero (or less than 0.1 ppm) haze, the Reply nevertheless contends that such methods are applied to GaAs and not to InP. Such an argument is not persuasive is not relevant because it is not applied in rejecting the claims.

Examiner notes that Morisawa, published in 1996, as explained in the rejection above, specifically discloses how to mirror polish InP substrates to obtain "haze free" haze due to surface roughness.

CONCLUSION

4. A shortened statutory period for reply to this Office Action is set to expire **THREE MONTHS** from the mailing date of this Office Action. Applicant is reminded of the extension of time policy as set forth in 37 CFR § 1.136(a).

Any inquiry concerning this communication or earlier communications from an Examiner should be directed to Examiner Hrayr A. Sayadian, at (571) 272-7779, on Monday through Friday, 7:30 am – 4:00 pm ET.

If attempts to reach Mr. Sayadian by telephone are unsuccessful, his supervisor, Supervisory Primary Examiner Wael Fahmy, can be reached at (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available only through Private PAIR. For more information about the PAIR system, see http://pair-direct.uspto.gov. The Electronic Business Center (EBC) at 866-217-9197 (toll-free) may answer questions on how to access the Private PAIR system.

/Hrayr A. Sayadian/
Patent Examiner, Art Unit 2814